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Published in:
Understanding Student Participation and Choice in Science and Technology Education

Publication date:
2015

Document version
Peer reviewed version

Citation for published version (APA):
Ulriksen, L., Madsen, L. M., & Holmegaard, H. T. (2015). The first-year experience: students' encounter with science and engineering programmes. In E. K. Henriksen, J. Dillon, & J. Ryder (Eds.), *Understanding Student Participation and Choice in Science and Technology Education* (pp. 241-257). Springer Science+Business Media. Education

15 The first-year experience: Students' encounter with science and engineering programmes

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Abstract To increase the number of graduates in science, technology, engineering and mathematics (STEM), it is not sufficient to attract more students to the programmes. It is equally important to ensure that the students complete their studies. This chapter presents a qualitative analysis of the experiences of 20 students who entered a science or engineering programme at a Danish university. In this longitudinal study, narrative interviews were carried out with the students during their first year. The chapter explores how the students were striving to bridge the gap between what they had expected the programme to be like, and what they experienced when entering. Drawing on Tinto's model of student departure, the academic and social integration is discussed. The analysis suggests that the curriculum of the STEM programmes makes it difficult for students to become academically integrated. This is primarily because of the sequencing (when do students meet which content?), the pace, and the teaching and learning activities.

Keywords: Expectations, Experiences, Students choice, First year, Identity, Qualitative

Background: Understanding students' first-year experiences

Each year, higher education institutions succeed in attracting students to STEM programmes. However, recruitment is only the first step towards the graduation of a STEM student. Making the students stay is equally important. Unfortunately, about one third of the students entering tertiary education do not complete the programme (OECD, 2010), and this is not least the case for students attending STEM courses (OECD, 2008). Analyses of Danish data (chapter 14 in this volume) found that when students opt out of a STEM higher education programme, only about one third of them enter another STEM programme. In fact, more students leave STEM to go to non-STEM programmes than do re-enter a

programme within STEM. Retention, therefore, is a key concern for increasing the number of STEM graduates.

A principal finding in the review of research on retention and non-completion (Chapter 13 and Ulriksen, Madsen, and Holmegaard (2010)) was that retention should be considered within a broader perspective of the students' learning experiences during first year rather than as an isolated problem. Further, the review pointed to the importance of applying an identity perspective when studying student departure from STEM, rather than merely regarding the students who drop out as less capable or ill-prepared. Even though prior schooling experiences and performance are related to student persistence (cf. Chapter 14), they cannot sufficiently explain the non-completion patterns. Likewise, it is not consistently the less able students who leave their STEM studies prior to graduation. The leavers are in many respects quite similar to the students who stay on the programmes (Seymour & Hewitt, 1997).

That different elements affect the students' decisions to stay or leave are reflected in the widely used model of student departure developed by Vincent Tinto (1975, 1993) (cf. chapter 13 in this volume and (Ulriksen et al., 2010)). Tinto's model emphasised that student leaving is occuring over time rather than being a discrete event. Further, he included different factors as influential on whether students were leaving or nor, including pre-entry qualifications and family background. A core element in Tinto's model was 'the concept of integration and the patterns of interaction between the student and other members of the institution especially during the first critical year of college and the stages of transition that marked that year'(Tinto, 2006-2007, p. 3). This has also been labelled the social and academic integration of the students. The integration relates to the students' experiences with the institution, their interaction with fellow students and with faculty and other staff in formal and informal settings.

The *academic integration* refers to two dimensions. The first is the students' experiences of congruence between their own abilities and skills and the demands of the programme (for example, whether they pass the exams or what grades they get). This can be considered the institutions evaluation of the student, as Tinto put it in an early version of the model (Tinto, 1975). The second is what Tinto in the 1975 paper labels 'intellectual development' which can be considered the students' evaluation of the academic system (Tinto, 1975, p. 104). It relates to the students' experiences of congruence between their interests and academic orientation and what they meet at the course. Academic integration, in other words, concerns the students' sense of belonging in the academic environment of their study programme in terms of feeling that they can meet the requirements and that they find it interesting and relevant. This integration process both occurs in formal settings of the different teaching and learning actitivities and in informal contexts outside class where students meet and interact with the staff.

Social integration refers to the process of students becoming part of a social community of fellow students at the programme and gaining a sense of belonging. This also relates to both an informal and a formal context. Examples of formal settings are student societies and unions while the informal parts of the system are when students are simply hanging out together at campus, going to cafés together etc.

The systems of the academic and the social integration are intrically interwoven (Tinto, 1993). When, for instance, students sit together at university working on exercises for the chemistry class the following day, they are involved in an activity that relates to the academic integration in their doing the course work and their experiences of that. They are also involved in an incident of social integration because the study group provides a sense of being a part of a studying community and because the group may talk about other stuff than chemistry and even may continue going to a café after having completed the assignments. Tinto(2006-2007) made the point that in colleges where students do not live at campus most of the informal integration has to take place in relation to the teaching and in the classroom, because the conditions for out of class interaction are different than at residential universities. As most universities in many European countries, including Denmark, are non-residential, this is indeed an important point.

The model of Tinto has been criticised for being insensitive to social and cultural differences. It has been claimed that the model required students to commit cultural suicide (Tierney, 1999) in order to assimilate to the dominant academic culture. Although it is not necessarily the consequence of the model and the process of integration that students need to conform to one culture, there has been articulated a need to develop the model to achieve a more nuanced understanding of the complexity of the process of integration (Braxton, Milem, & Sullivan, 2000; Tierney, 1999; Tinto, 2006-2007).

However, the idea of integration as a pivotal component in student persistence appears as a viable way to understand students' experiences when entering university. Integration can be considered a process of socialisation. The choice of study is, to a large extent, linked to the students' thoughts about who they wish to become (Illeris, Katznelson, Simonsen, & Ulriksen, 2002; Schreiner & Sjøberg, 2007), and therefore the congruence between these ideas and the students' experience of belonging or not is highly important (Holmegaard, Ulriksen, and Madsen, 2012; Bøe, Henriksen, Lyons & Schreiner, 2011). Consequently, the academic and social integration are processes where students' prior knowledge, experiences, expectations, and inclinations towards the study meet with the culture, traditions, and pedagogical forms of the programme. Ulriksen (2009) argues that a study programme holds "an implied student". This means that study programmes presuppose that students attending the programme possess a particular study practice, attitude, interest, and behaviour.The structure of the programme, the sequence of the courses and modules, the teaching and learning

activities, etc. all presuppose particular traits, attitudes, or competences. The students need (consciously or not) to detect and adapt to these presuppositions in order for the teaching and learning to succeed. For instance, a programme can imply that students have particular interests in the field, whereas if they do not, the students may fail to see the point of the course. The implied student is conveyed through the structure, the curriculum, etc. A programme may hold more than one implied student, and these may even be incompatible in some extent, but the number is limited.

In the process of socialisation, students may assimillate completely, but students may also be forming subcultures where they, for instance, seek to balance the culture of academia they are entering with the culture they bring with them, rather than abandoning their cultural background (Hurtado & Carter, 1997). Likewise, students may engage more in some parts of the programme or aspects of the discipline than in others. In some academic disciplines there are differing ideas about what content is the more relevant (Becher & Trowler, 2001) and in that case students may orient themselves towards one part of the discipline rather than the other, for instance, a biology student prioritising macro biology before micro biology or a physics student engaging in theoretical physics rather than experimental physics.

Following narrative psychology (cf. chapter 3 in this volume), the process of socialisation and of balancing involves the students in constructing and reconstructing narratives concerning their previous experiences, their intentions, anticipations, and perspectives, their experiences at the programme, and so forth. The students construct narratives to make meaning and a sense of coherence to themselves and their surroundings (Bruner, 2004; Polkinghorne, 1988). What narratives the students will be able to construct are framed and confined by the social and cultural environment (what may be recognised by the surroundings as a sensible and legitimate narrative) and by the students' cultural and social background and history (what repertoire does the student have for constructing a narrative, both concerning knowledge, experience, and story "templates").

In this chapter we will analyse the first-year experiences of STEM students at university with a particular focus on the integration and socialisation process of the students as it happens in the encounter with the STEM study programmes they have entered. Our focus is to understand how students engage in the studies, and how they make sense of their experiences compared to the expectations they had. The objective of the analysis, therefore, is to *expand and refine our understanding of how students cope with their first-year experience and what we may learn from this concerning student completion* at STEM higher-education programmes.

Methods

The empirical basis consists of interviews with 20 first-year students at STEM programmes. The students were selected from a sample of 134 students finishing upper-secondary school in the summer of 2009. Of the 134 students, 38 were interviewed two months before the completion of upper-secondary school. Based on the students' study plans, 20 students were selected for interviews after having entered first year at university. Three of these were students who in spite of expressing a strong interest in science still opted for a course within the humanities. Eventually, two of these opted out of the humanities to enter a STEM programme. The remaining 17 entered a STEM programme (including one entering veterinary medicine) and 13 of these were interviewed more than once during their first year, some up to five times. Four students did not show up for the second interview. Six of the students were interviewed after having entered the second year of their programme. Some of the 20 selected entered university straight after upper-secondary school while others had a gap year. Eight were interviewed during their gap year (see Holmegaard, Madsen, and Ulriksen (2012) for details on the method).

The interviews were semi-structured (Kvale, 1996) and conducted using a narrative approach (Andrews, Squire, & Tamboukou, 2008; Bruner, 1990; Hollway & Jefferson, 2000). The interviewee was encouraged to tell about what it had been like to begin studying at the particular programme. The interviewer's questions mainly aimed at inviting the interviewee to elaborate or expand the narrative.

In the analysis, the interviews were coded using the Atlas TI software. Rather than generating the themes from the text, the coding used codes that were constructed on the basis of Tinto's concepts of academic and social integration and the concept of the implied student. This is what Kvale (1996) calls a theoretical understanding of the interview.

Results

We will begin the presentation of the results by telling the brief versions of the transition of two female students in the sample. The purpose is to offer two more detailed accounts of entering university before we present the results in a more thematic structure.

Emily and Elisabeth[1]

[1] All student names are pseudonyms.

In upper-secondary school Emily became convinced that chemical engineering was the right choice for her and she had visited the technical university to make sure it was. Her experience with the programme, however, was frustrating. She found the quality of the teaching inadequate, she experienced the workload overwelming and the content difficult. The first semester, she told, was supposed to be the hardest and the saying was that 'everybody fails this course'. At the same time, the content of the teaching did not reflect her interests. In the second interview a couple of months after she entered, she explained that what she liked about science was that 'you describe reality, you can calculate on reality and find out how things work and what we can do to make things better'. So far, she had not experienced much of that but 'I think you have to begin at a basic level, so I think it will come'. During the first months, the teaching was predominantly theoretical with very limited relation to reality or to their later profession. Emily told she missed of seeing things (for instance, in experiments) rather than dealing with them in a table.

In the interviews during her first six months at university, Emily tried to find explanations for the difficulties she experienced. She both questioned the quality of what the university offered and of her own study efforts. Hence, the interviews reflected a continuous negotiation of her interests, her sense of her own skills and efforts, and her experience of the teaching and learning environment of the programme. When entering the second semester, she decided to leave. She had been failing exams after the first semester, but this was not the sole reason for her decision. After having opted out, she explained in an interview:

> I felt myself being stupid in all the courses and I couldn't figure things out. I was not motivated to study and it became too tough and I did not feel that I could keep my self-confidence and self-respect when I got the feeling of being stupid every day. Then I thought I needed to make a plan about what to do.

She felt that staying at the programme might undermine her sense of self and be detrimental to her identity. Emily's encounter with university combined a surprise by the difficulty of the subject with an experience that the teaching offered little help for understanding. Furthermore, the content of the teaching had few links to her initial interests and she did not succeed in establishing a social environment at the programme that could support her, just as this was not facilitated by the programme. Her study group was working poorly both in terms of work discipline and the way the group members talked to each other, and eventually it broke up. As a result, Emily lost contact with two female students she had been seeing quite a lot during the first months. This troubled her.

Emily's integration was neither successful at the academic or at the social level. The social integration suffered from a combination of a poorly functioning study group with no support from the programme and of her feeling that the informal activities were difficult to attend on top of the long hours the students already spent at university. The academic integration was under strain for several reasons: the content, the pace, the mode and quality of the teaching, the academic require-

ments. The unsuccessful integrations eventually made her leave the programme and the institution, and later enter another non-STEM programme.

A quite different experience was that of Elisabeth who had no doubts, either, about what to study after upper-secondary school. She entered an engineering programme in land management. When interviewed a few months into the first year, her general impression was that 'each time we have been introduced to something new, it has added something interesting to the discipline'. During the first week of introduction, the new students had visited potential future workplaces, offering an impression of what she could do after graduation. Having this was important for the studying to make sense to her. The social life at the programme was positive, not just during class, but the students also went swimming or bowling together in the evenings. The small number of students at the programme (less than 20) combined with project work in groups being the salient mode of teaching at the programme provided a frame for the students to get to know each other. They did not have much contact with the lecturers in mathematics, but each project group had a supervisor assigned that they met with in the group and whom they could call in for meetings. Elisabeth described her interests and motivation as growing; but as she said: 'It doesn't take much before I'm saying: This is fun, this is interesting'.

Elisabeth's narrative presented a successful process of integration, both socially and academically. She got along well with her fellow students, she was involved in social activities, and she found the academic content stimulating and interesting. The future after graduation appeared promising as well.

Compared to the experiences of the 18 other students, Elisabeth and Emily represent each their end of a continuum of successful integration, but more students had experiences similar to those of Emily's than to those of Elisabeth.

Academic integration

The academic content

A great deal of the students told about being surprised that the content they met during the first year was different from what they had applied for. This was not least the case when the students commented on the modules in mathematics that was part of the first year at most of the programmes. An engineering student told that he had asked a professor why they should have mathematics, but the professor had stated that he did not know that either. A student in biochemistry supposed that they should have the module in mathematics of social reasons because they had been told that they would not be using any of the mathematics taught in the module whereas the mathematics they were to use would be taught in a later module. A computer student had expected the study to contain some mathematics in addition to the coding, but it had turned out that it was the other way around, at least in the beginning.

Other students told they had been surprised by other aspects of the programmes: that the programmes were less practical than expected (this was the experience for some of the students at the biology-oriented programmes) or that they were less theoretical (which both a student at sport science and at professional engineering told). The experience of the content of the programme and the balance between theoretical and practical elements were related to the students' sense of identity. An example of this was the female student, Frida, who in an interview during her gap year told that she would apply for admission at biochemistry. She was fascinated by understanding the chemical aspects of the body, that 'it's not just biology all of it' and that she would like to work with medico-chemistry. When entering the programme, she found that all the auxiliary modules were placed at the beginning

> '… which in one way is pretty smart because you need the basic knowledge. But they kind of forget that they need to catch people at the programme, saying "this is what we are going to do"' (Frida, biochemistry, second interview)

Even though she acknowledged a need for auxiliary subjects she also regretted that the sequencing of the courses during first year meant that the biochemistry students had to wait until the end of first year before they met courses in biochemistry and maybe 'people will not get caught': 'It's too bad for those who have already dropped out. There are some who have dropped out because they simply didn't find it interesting enough', she said in the second interview at first year.

Frida herself was quite positive about the study and felt like she belonged there. This was partly related to the social environment of the programme, partly to the academic part. The academic dimension not least had to do with the laboratory work. When she was wearing the lab coat, she felt how she

> 'turned into a professional ... becoming entirely different, straightening the back, becoming proud. [...] And I see myself from the outside and I say: This is actually quite alright' (Frida, biochemistry, first interview)

The experience of meeting something different from expected was endemic in the interviews. However, even though some students seemed to have been less careful in their search for information the experience also students who had looked up information about the programmes were facing a different content than expected. This experience seemed to be related to the lack of a meaningful link between the different modules – either because the programmes failed to convey the meaning of the modules or because the meaning was not there.

The teaching: pace, quality, form

Most of the students needed some time to adjust to the mode of teaching at university, mainly the lectures with large number of students and more emphasis on the students' own reading and doing exercises. The students' sentiments towards lectures were diverse. Some experienced the lecturers as good at explaining the con-

tent when it had been incomprehensible when they read it in the textbook. Some told about the lecturers as open and anxious to tell the students more if they approached them after class, while others described them as more remote compared to the teachers the students knew in upper-secondary school.

Obviously, the quality of the teaching could be quite diverse, too. Some lectures could be uninspiring, difficult to follow, and with teachers who judged by the students' descriptions could do with some pedagogical supervision. An engineering student described a teacher in chemistry who was just 'babbling away, writing random chemical equations on the blackboard' and the difficult part was to figure out what was relevant. In other situations, the teaching could ignite the students' interests and fascination. In some of the narratives, the difference between the inspiring and the less inspiring teaching appeared to be related to the pace and to the possibility of engaging more deeply and becoming absorbed in the content. High pace prevented the students from delving into the subject matter.

Frida, quoted previously, experienced that the teaching made the students adopt an approach to studying where they learned how to solve problems at exercises without necessarily learning the theory behind them. She remarked that she supposed it was the theoretical understanding they would need later on, but what they were tested on at the exam was solving problems. Birgitte, another female student, had two modules at the same time: one in mathematics and one in biotechnology. She described the difference between the two. A math day was 'Read. Listen. Understand. Do exercises'. A biotechnology day was 'Think. Rephrase. Explain. Things like that to make you understand it yourself'. Along with Elisabeth, presented in the introduction, Birgitte represents two of the few examples where project work took up a substantial part of the teaching. Most of the students attended programmes where the teaching was organised in lectures, exercise classes or tutorials, and lab exercises.

The student narratives suggested that project work succeeded in conveying a fascination and academic satisfaction to the students. Elisabeth experienced the programmes as fascinating and that they were introduced to new and interesting things. Birgitte worked in a group on a topic within biotechnology they had chosen themselves and investigated that. The project had presented her with an idea of where biotechnology could take her and a sense of 'having come to the right place', as she said. Interestingly, Emily who opted out of engineering, had one of her positive experiences with the programme shortly before she left when they were doing a three-week project. She liked the teaching being organised as project work even though it was hard having an exam after just three weeks, but she appreciated the opportunity to go deeper into something.

The academic requirements

Some of the students found the academic requirements in the teaching and the assignments challenging. However, they did link this to the academic level in the

sense of how complicated, abstract, or 'difficult' the content was, but rather to the teaching or the kind of learning required. To some extent, this may have something to do with the students trying to construct a narrative where they appeared as competent even though they were struggling to meet the requirements. However, it could also reflect that whether the students meet the standards of the course requirements or not is not solely rooted within the individual student as a particular ability or trait. Rather, the achievement of a particular student depends on the relation between on the one hand the requirements from and the opportunities provided by the learning environment and, on the other, how the student interprets the environment. This interpretation builds on the student's background and prior knowledge and experiences. This means that a particular learning environment may impede some students in expressing their competences, but facilitating the participation of other students.

One example was an engineering student who during the first interview stated that 'I don't think the content is difficult, but there is just so much of it at one time that you are soon falling behind' (Djemal). In the second interview a couple of months later he told that he struggled with how 'to put the formulas together. I always struggled with that – I should be using these formulas and not the other'.

Djemal did not consider himself one of the 'clever heads' at the programme and he experienced having difficulties with the content – even if he thought the level was okay; in fact, he had expected it more difficult. Still, both the pace of the teaching and the textbooks being in English, made his work on meeting the requirements more difficult. Other students told about trying to find study techniques to learn content by heart (for instance, chemical bonds) and a student at computer science realised that he needed to change his way of studying when he failed some exams.

Overall, when the students found the content of the programmes difficult and challenging this was not simply related to the courses presenting them with new and more demanding content. Apparently, the students had difficulties finding a way of coping with the teaching and with how to organise their studying when they were presented with large amount of textbook materials, frequently in English (a second language to the students), and with the expectation that they should be able to both understand and absorbe extensive material by heart (Ulriksen, 2013).

A particular challenge occurred when the teaching presupposed that the students had particular prior knowledge and experiences that were not explicitly required at entrance. This could be that the teachers assumed that the students had learned some specific disciplinary content during upper-secondary school (which they had not), or that the students had a particular level of knowledge in one of the disciplines at the programme (e.g., chemistry in a biology programme), but where the students eventually had taken the subjects at different levels in upper-secondary school and therefore entered the teaching with different prior knowledge.

A male student at computer science told how the teaching presupposed particular skills:

> JAVA is a language that quite a lot of enthusiasts have used for coding before, and therefore it feels like they [the teachers]expect that most of us already have experiences with programming in JAVA, and then they expect that we almost all of us are able to use if for coding. And I haven't coded before, and it's a bit like offsiding new programmers, 'cause I'm sitting there thinking 'great', and then they are standing there just talking and talking and talking, and you are thinking you're not really learning anything from it. (Belal, second interview).

The narratives of this student indicated that the teaching at computer science assumed the students to be computer enthusiasts who had been playing with their computers as a hobby (there is hardly any formal computer science teaching in Danish primary or secondary school), learning coding on their own, experimenting with writing small programmes. This was one example of courses expecting particular knowledge or approaches from the students. Another was the engineering student, Filip (reported in chapter 3 in this volume), who after having entered the programme and having met with a professor serving as a mentor changed his perspective of studying engineering from aiming at working with management to focusing on the engineering. In Filip's case, he adjusted his perspective to one more in accordance with the usual and legitimate one.

Overall, the academic integration was by many of the students experienced as troublesome. The content of the courses was different from what they expected; the teaching and learning activities were difficult to get used to and did not always appear to facilitate learning; and the academic requirements were not only challenging because of being at a more advanced level, but also because the students were unprepared for some of the study methods necessary for handling the amount of material and the pace of the teaching.

Still, the students were generally patient and accepting the choices of the programmes they attended, trying to find ways to cope with the sense of insecurity, concerning their academic competence and whether the course was actually the right choice.

Social integration

One way of coping was to prioritise the social integration. Once again, Frida can provide an example. In the third interview conducted during spring she expressed that the social network established at the programme had been crucial to her persistence:

> I don't think I would have gotten this far. I think the social has been really important for me – both having somebody to study with, but also having a social life in here. [...] Those girls [in the study group] have really helped me a lot with understanding some of the theory behind the assignments. (Frida, third interview)

An important point is that the social network both has academic and social implications. When asked what advice she would give to students entering the programme, Frida answered: 'You need to establish a social network. It shouldn't be all work'.

Most interviewees stressed the importance of a social network. Some students, like Frida, considered the social integration as the key to retention. A male student of mathematics who was even more interested in the course content than he had expected to be, had difficulties becoming socially integrated, and said: 'I use quite a lot of effort on that. It's almost more important than doing well at the course. Because, if I don't feel comfortable then I don't think I can make it through' (Bastian). Another student told how she had given priority to becoming socially integrated during the first year, both because she, like Bastian, considered it of paramount importance, and because she expected the first year of study to be somewhat boring due to the auxiliary courses they were to take.

Hence, social integration is important for feeling comfortable and having a sense of relation to the place. The social integration is also important because the social network offers resources for coping with academic content. The students' informal interactions outside class provides access to help and support beyond the study group. Further, the sense of not being the only one struggling was mentioned by some of the interviewees as important in their decisions to persist.

Based on the interviews, it appeared that for most of the students the social integration was more successful and smooth than the academic integration. The experience of Bastian, feeling the other way around, was unusual. There were, however, examples of students who experienced a sense of isolation. One reason could be the geographical distance between the university and the student's home. Another was expressed by a student with an ethnic minority background, who experienced it difficult that most of the social activities involved consumption of alcohol. The apparently successful social integration process of the majority students is a fortunate situation, but it also calls for even more attention to the minority that for different reasons (personal, geographical, religious, etc.) have a harder time finding a social space at the programmes.

The expectancy-experience gap

Virtually all of the 20 students experienced a gap between what they had expected and what they experienced at the courses (for a more detailed discussion of this gap, see Holmegaard, Madsen, and Ulriksen (2013)). For most of the students, the gap related to different aspects of the academic integration. The size of the gap differed between the students, but it was experienced by all the students. Consequently, the institutions should expect the students to be faced with a need to adjust their expectations in relation to becoming a higher-education student and that

this adjustment process may require some effort. This is an important point, however trivial it appears at first sight.

The students had to find ways of coping with this expectancy-experience gap. For some students the renegotiation of their ideas about studying was a continuous and sometimes arduous process throughout the first year. In that process, students would try to create a sense of coherence between their expectations and their experiences by reconstructing their narrative about what they would meet at the programme. Some students tried to adopt the logic of the programme, as it was, inter alia, expressed through the sequencing or the teaching methods even when this same logic was challenging for their making sense of studying (for instance, that toolbox courses should precede the more interesting courses). Other negotiations could concern whether the choice of programme was in fact the right choice (cf. chapter 3) and whether the programme suited the student or whether the student was fit for the programme. This negotiation would affect the students' sense of who they were, their construction and reconstruction of their identity. Most of the students included in this study succeeded in this renegotiation process in the sense that they stayed at the programme. Others, like Emily whose story was presented in the beginning of this chapter, opted out because the study experiences were incompatible with her maintaining a sense of self.

Some students managed to reconstruct their expectations in a shorter and faster process bringing them at terms with their experiences. For some, like Elisabeth, this was due to a fairly small gap between the expectancies and the experiences. For others, it was because the students quickly found a way of coping, either by transforming their interests or by submitting themselves to the programme and not expecting much. In some cases there was also an element of the students adjusting and developing their study techniques and strategies, for instance, inventing memory games, involving themselves in study groups working at the university rather than individually at home, adjusting their ways of studying. During this process the importance of the social integration became visible because fellow students, and sometimes older students, could pass on tips and ideas about what to do.

Some students engaged themselves in extra-curricular activities to find resources or experiences that could help them in coping with their programme. A computer science student had his motivation revived at a meeting organised by the trade union presenting possible career paths after graduation. Another student in computer engineering involved himself in working with computers with his friends rather than attending classes at the programme. He did enough to keep track of the courses, but his main focus was on working with computers and systems at the dormitory because it matched his interests better.

Discussion: integration, negotiations, and the implied student

The experiences from attending first year at a STEM university programme all included the challenge of bridging the gap between the expectations the students had about what the studies would be like and what they eventually experienced after having entered the programmes. As a part of this, students needed to renegotiate their images of studying and of themselves, that is, it required them to carry out identity work in order to establish a sense of meaning and coherence between what they expected and what they experienced.

This effort of the students to bridge the gap could be considered as a process of integration following the model of Vincent Tinto (1993). The students' narratives also showed that both the academic and the social aspects of the first-year experience are of importance in this process. Further, the academic integration consists of meeting the courses' requirements, of being able to handle the teaching and learning activities of the programmes (including the pace of the teaching), and of coming to terms with the content of the courses and modules the students attend during the first year.

Our analysis suggested that the social and the academic integration are related, not least that the social integration may help the students to endure the strain put upon them by the academic life, keeping of the high pace and attending courses dominated by auxiliary disciplines rather than the topics the students had opted for. The social integration can both provide a sense of belonging that can balance the doubts generated by the academic integration process and it can offer resources the students can draw upon in their endeavours to meet academic requirements and endure the long road some students need to travel before getting to the interesting modules.

The different elements involved in this process further emphasise the point that academic and social integration is a complex process. For some students it is a process of assimilation because the programme fits the interests and intentions of the student. This was the case for one, perhaps two, of the students in our sample. For others, it is an assimilation process where the students accept that they have to endure a period of boredom and lack of meaning in waiting for the interesting content at later modules and through this they conform to the way they are expected to study. Others, still, accommodate the study experience in a way that both allows them to become sufficiently integrated to pass the exams and being recognised by the programme as a legitimate student and to engage in extra-curricular activities that meet some of the interests that are not catered for by the programme.

This means that whether students have to commit cultural suicide or not (Tierney, 1999) is to a wide extent dependant on the way the students succeed in bridging the expectation-experience gap. While some need to renegotiate their ideas and perceptions in a way that submit their sense of self and of meaning to the logic of

the programmes, other students manage to maintain their initial interests and perspectives. However, some of the latter do so by compartmentalising their study experiences so that their subjective sense of relevance is nurtured parallel to rather than integrated with the progression and content of the study programme. Consequently, both assimilation and accommodation can take on different shapes and they represent variations of integration. Hence, Tinto's model draws attention to the pivotal role of integration, but it does not provide an understanding of how this process occurs.

The present analysis suggests that the curriculum is a focal point in the integration and retention of students. The integration of students is related to the content of the courses, to the sequencing and mutual relation of the different modules, to the pace of the teaching, to the kinds of teaching and learning activities students are involved in, and to the kind and extent of student involvement in the courses. This involvement of the students includes to what extent the curriculum leaves room for the students to recognise the content they found interesting when they applied for the course and what kinds of engagement with the content the teaching and learning activities allow.

However, the social context of the studying and the students' opportunities for establishing social networks are also important. Even though establishing social networks could be considered the responsibility of the students themselves, the programme provides a framework that could both facilitate the students' social interaction or hamper it. This framework consists of elements related to the curriculum and teaching practices, but also to the physical options at the campus and to whether the institution consider it a part of its role to facilitate students' social integration. As the social integration is strongly interwoven with the students' academic integration there seem to be a potential for institutions to develop and use this knowledge to support students in their first year of study.

The analysis also drew the attention to how the pre-entry qualifications are part of the integration process. As we noted previously, the students' background (be it social, ethnic, or gender), their prior academic achievements, and the circumstances concerning their choice of programme all feed in to the students' construction of narratives when they meet the university courses. Therefore, these pre-entry qualifications, as they are labelled in Tinto's model, should not be considered as having an impact prior to the negotiation of the students' narratives. They are an integrated part of the continuous negotiation process and therefore the students are differently equipped for the integration process.

In this process, the implied student of the programmes will play a role. The degree of similitude between the implied student and each individual (empirical) student will influence the process of integration because it presents the students with different requirements in their renegotiation. Students with a background and approaches to the studies that differ from those of the implied student will have to perform a more extensive renegotiation than students whose background and ap-

proaches are similar to those implied. As a part of this, they will also have to balance how much they are willing or able to adjust in order to meet the courses' requirements.

The integration of the students, however, was not only related to the students' sense of belonging or interests. It also affected their approaches to studying and hence supposedly the quality of their learning. This not least had to do with the students' experience of high pace that persuaded some of the students to adopt a study approach where the course content was 'taken in' rather than understood. Both the narratives and previous research (Entwistle, 2009) indicate that the pace and amount of content in the teaching reduces the quality of the learning. These accounts were contrasted by less frequent descriptions of learning situations such as project work and to some extent in laboratory work, that is, teaching formats characterised by more active participation by the students, something that has been seen to improve student retention (cf. Crosling, Thomas, and Heagney (2008)).

Conclusion

The present study has found that the social and academic integration of first-year STEM students involves a process of negotiation and reconstruction where the students balance different elements in order to bridge the gap between their expectations and their experiences. At the core of this process is the identity work of the students, and the outcome may both be that of assimilation and of accommodation. We also found that the social and academic integration are closely related, not least that the social integration provides access to resources among fellow students that can be of help in the academic integration.

In the act of balancing, students' social background and their prior knowledge and experiences encounter the conditions and requirements of the study programme and institution. Therefore, student background and pre-entry qualifications are the resources the students can draw upon when they engage with the course curriculum and when they reconstruct and negotiate their narratives concerning studying. These resources do not just concern academic preparation or careful information seeking prior to entering the programme. They include which patterns of interpretation, understanding, and narratives are available to the students in the balancing and identity work. The integration and retention of the students, therefore, are related to the extent to which students can bridge the expectancy-experience gap, and this partly has to do with the distance between the implied student of the programme and the background and orientation of the student.

The analysis found that the curriculum is crucial in this process, even though the facilitation of the students' social integration is influential as well. The students' narratives of their experiences with the first-year STEM curriculum suggest that

the academic integration is hampered by a sequencing that delay the time when the students meet what they applied for, and a pace that is so high that students rely on recollection rather than understanding. A principal challenge of first-year students is how to cope with these experiences in a way that give them a sense meaning and coherence in the study programme.

This means that measures to increase retention should not mainly focus on the preparation of the students, but rather on the curriculum of the first year, both concerning content, sequencing, pace, and the teaching and learning activities students are involved in. This could not just increase retention. It might also improve the quality of learning for the group of students as a whole in accordance with the point made by Harvey, Drew, and Smith (2006) that retention should be addressed as an issue concerning first-year experiences rather than as a separate issue.

It is of paramount importance that the first year at university allows the students to get a sense of where they are going and how the different courses contribute to the overall goal. They should be able to establish a link between who they have been, who they are, who they wish to become, and the course they are attending. Since the students are different and enter with different perspectives this calls for a curriculum that is sufficiently flexible in form and content that it allows for different interests and interpretations of what studying the particular discipline means and where it might take them.

References

Andrews, M., Squire, C., & Tamboukou, M. (2008). *Doing narrative research*. London: Sage publications.

Becher, T., & Trowler, P. R. (2001). *Academic Tribes and Territories. Intellectual enquiry and the culture of disciplines*. Maidenhead (UK): The Society for Research into Higher Education & Open University Press.

Braxton, J. M., Milem, J. F., & Sullivan, A. S. (2000). The influence of active learning on the college student departure process - Toward a revision of Tinto's theory. *Journal of Higher Education*, 71(5), 569-590. doi: 10.2307/2649260

Bruner, J. (1990). *Acts of meaning*. Cambridge, Massachusetts: Harvard University Press

Bruner, J. (2004). *Life as Narrative*. Social Research, 71(3), 691-710.

Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: young people's achievement-related choices in late-modern societies. *Studies in Science Education*, 47(1), 37-72. doi: 10.1080/03057267.2011.549621

Crosling, G., Thomas, L., & Heagney, M. (Eds.). (2008). *Improving Student Retention in Higher Education. The role of teaching and learning.* Milton Park, Oxon: Routledge.

Entwistle, N. (2009). *Teaching for Understanding at University. Deep Approaches and Distinctive Ways of Thinking*. Basingstoke, Hampshire (UK): Palgrave Macmillan.

Harvey, L., Drew, S., & Smith, M. (2006). *The first-year experience: a review of literature for the Higher Education Academy*: The Higher Education Academy.

Hollway, W., & Jefferson, T. (2000). *Doing Qualitative Research Differently: free association, narrative and the interview method*. London: Sage Publications.

Holmegaard, H.T., Madsen, L., & Ulriksen, L. (2013). A journey of negotiation and belonging: understanding students' transitions to science and engineering in higher education. *Cultural Studies of Science Education*, 1-32. doi: 10.1007/s11422-013-9542-3

Holmegaard, H.T., Madsen, L. M., & Ulriksen, L. (2012). To Choose or Not to Choose Science: Constructions of desirable identities among young people considering a STEM higher education programme. *International Journal of Science Education*, 36(2), 186-215. doi: 10.1080/09500693.2012.749362

Holmegaard, H.T., Ulriksen, L. M., & Madsen, L. M. (2012). The Process of Choosing What to Study: A Longitudinal Study of Upper Secondary Students' Identity Work When Choosing Higher Education. *Scandinavian Journal of Educational Research*, 1-20. doi: 10.1080/00313831.2012.696212

Hurtado, S., & Carter, D. F. (1997). Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging. *Sociology of Education*, 70(4), 324-345. doi: 10.2307/2673270

Illeris, K., Katznelson, N., Simonsen, B., & Ulriksen, L. (2002). *Ungdom, identitet og uddannelse*. Frederiksberg: Roskilde Universitetsforlag.

Kvale, S. (1996). *InterViews. An Introduction to Qualitative Research Interviewing*. Thousand Oaks London New Delhi: Sage Publications.

OECD. (2008). *Encouraging student interest in science and technology studies*. Paris: OECD (Organisation for Economic Co-operation and Development).

OECD. (2010). *Education at a glance 2010*. OECD indicators Retrieved from http://www.oecd.org/dataoecd/45/39/45926093.pdf

Polkinghorne, D. E. (1988). *Narrative Knowing and the Human Sciences*. Albany: State University of New York.

Schreiner, C., & Sjøberg, S. (2007). Science education and youth's identity construction - two incompatible projects? In D. Corrigan, J. Dillon & R. Gunstone (Eds.), *The Re-Emergence of Values in Science Education* (pp. 231-247). Rotterdam/Taipei: Sense Publishers.

Seymour, E., & Hewitt, N. M. (1997). *Talking About Leaving. Why Undergraduates Leave the Sciences.* Boulder, Colorado (US): Westview Press.

Tierney, W. G. (1999). Models of minority college-going and retention: Cultural integrity versus cultural suicide. *Journal of Negro Education*, 68(1), 80-91. doi: 10.2307/2668211

Tinto, V. (1975). Dropout From Higher Education - Theoretical Synthesis of Recent Research. *Review of Educational Research*, 45(1), 89-125. doi: 10.3102/00346543045001089

Tinto, V. (1993). *Leaving College. Rethinking the causes and cures of student attrition. (Second ed.)*. Chicago and London: The University of Chicago Press.

Tinto, V. (2006-2007). Research and Practice of Student Retention: What Next? *Journal of College Student Retention: Research, Theory and Practice*, 8(1), 1-19. doi: 10.2190/4YNU-4TMB-22DJ-AN4W

Ulriksen, L. (2009). The implied student. *Studies in Higher Education*, 34(5), 517-532. doi: 10.1080/03075070802597135

Ulriksen, L. (2013). Naturvidenskabelige studiekompetencer. Hvad er svært for de studerende? [Study competences in science. What is difficult for the students?]. *MONA* (3), 44-63.

Ulriksen, L., Madsen, L. M., & Holmegaard, H. T. (2010). What do we know about explanations for drop out/opt out among young people from STM higher education programmes? *Studies in Science Education*, 46(2), 209-244. doi: 10.1080/03057267.2010.504549